phites and syrup of hypophosphites. The large amount of glycerin, as in elixir of calcium and sodium glycerophosphates and compound elixir of glycerophosphates, is objectionable because of the disagreeable taste which develops. On the other hand glycerin is preferred to syrup when the preparation contains a large percentage of acid or inorganic salt because sugar is so easily caramelized.

CHEMICAL RESEARCH DEPARTMENT,
PARKE, DAVIS & CO.,
DETROIT, MICHIGAN,
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ABSTRACT OF DISCUSSION.

MR. RAUBENHEIMER: While it is true that glycerin can be replaced to some extent, as Professor Ruddiman has reported, there are a great many preparations wherein it is absolutely necessary. The standards must be complied with, and the author has this in mind. The work done by him will, doubtless, prove of value in the revision of the standards.

PROTECTIVE OINTMENTS AGAINST MUSTARD GAS.*

BY JOHN M. WILLIAMS.

Mustard gas, dichlordiethylsulphide, is an intense vesicant as well as being very toxic when inhaled. It has a marked action upon the eyes, causing temporary blindness, and quickly produces intense hoarseness followed by inflammation of the lungs. It penetrates clothing, producing a flesh wound of much the same character as the burn from phosphorus.

Mustard gas is produced by passing dry, pure ethylene into sulphur chloride at a temperature maintained within very narrow limits. Of the manufacture I will not go into detail.

Mustard gas was first used by the Germans on the Ypres sector in July 1917, and proved a formidable weapon, and had the Germans been able to manufacture it then on such a large scale as the Allies were doing at the time of the Armistice, there is little doubt that the allied lines would have melted, with a different conclusion of the war.

The need for a protection against mustard gas is realized when you consider the terrible burning effect of the liquid or gas. A small drop of the liquid on the skin will cause a marked erythema within a few hours, followed by a large blister, and a sore that heals very slowly. Exposure to the vapor gives a similar result, the severity of the burn depending upon the concentration of the vapor and the length of the exposure.

In considering possible preventatives or curative agents, attention must be drawn to the fact that absolutely no immediate effect of exposure of the external skin to mustard gas can be noticed. This decreases the value of any possible curative agents, and to be efficacious must be applied shortly after exposure. Exhaustive investigations failed to find an effective curative agent, although washing the exposed parts with kerosene, or soap and water, within one minute would keep it from burning. If washed within one-half hour a redness would appear, but this treatment is impossible under field conditions.

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* Read before Section on Practical Pharmacy and Dispensing, A. Ph. A., New York meeting, 1919.

Protection from mustard gas may be secured in at least three different ways:

a. A protective outside suit to be put on when exposure is anticipated.

b. Protective underclothing, to be worn continuously.

c. A protective ointment, to be applied to the skin when exposure is anticipated.

The latter is the one this paper will treat with although we will show how it was also made effective by the underclothing.

From the first it was recognized that the use of ointments had three fundamental disadvantages:

a. It would be impossible to protect the whole body by the use of ointment. Such a wholesale application might result fatally.

b. The ointment would be apt to rub off.

c. Only an impervious, unpleasant coating could protect against liquid drops of mustard gas.

The advantages are:

a. A small amount would supply a large number of men with protection.

b. Such an agent could be rapidly manufactured.

c. On certain *limited portions* of the body such protection must be used.

d. It could be used for horses, dogs and other animals.

At the outset it was agreed that an ointment to be satisfactory should possess the following properties to the greatest possible extent:

a. It should protect against "Mustard Gas."

b. It should give protection for 24 hours.

c. It should not be easily rubbed off.

d. It should in itself be non-irritating.

e. There should be no toxic or unpleasant effects from continued use.

f. It should retain a proper consistency under service conditions and give a proper coating at the temperature of the body.

g. It should be simple and rapid to manufacture. The raw materials required should be such as were available.

h. The cost should not be excessively great.

To determine if the ointments were satisfactory, a standard method of testing must be had. So exactly one-tenth of a mil of the ointment was rubbed over three square inches of the skin; after the ointment was applied no effort was made to protect it from rubbing off.

For exposure of gas to the skin an apparatus was prepared as follows: A test tube $4^1/_2$ inches by $^1/_2$ inch was placed inside a tube 5 by $^3/_4$ inches, and the inner tube separated from the outer by pieces of cork on the bottom, and at the sides. In the inner tube a piece of glass wool was placed about 2 inches from the top, and on this was dropped 1 mil of Mustard Gas. This inner tube was kept stoppered when not in use.

For rapidity in making a large number of exposures eight such tubes were attached in a row to a heavy strip of rubber.

In testing the ointments a blank burn was put on at the same time a burn was put on the skin covered with the ointment, and this burn was compared with the blank and a percent given taking the blank as 100 percent.

This was called the standard test, but ointments which gave good results were subjected to the more severe tests.

In order to make the study of possible ointment materials as systematic and thorough-going as possible, the first series of over 50 ointments was made up as follows: It was considered that each ointment consisted of two parts. First, there was the metallic soap or other solid material which was considered to give the protection, and second, there was the oil or liquid material which was worked up with the solid, and which probably gave permanence, etc., to the ointment. The latter was called the ointment base.

Bases of the following composition were prepared and made into ointments, using zinc stearate, zinc oleate, and zinc linoleate, respectively, as the chemical protection:

Base A.	Raw Linseed Oil	89%	Base E.	Lanolin (30% Water)	100%
	Wax	11%		(Neutral Wool Fat)	
B.	Liquid Petrolatum	90%	F.	Lanolin	98%
	Paraffin	10%		Gum Arabic	2%
C.	Olive Oil	89%	G.	Liquid Petrolatum	77%
	Wax	11%		Paraffin	14%
D.	Cocoanut Oil	95%		Tar	9%
	Paraffin	5%			

The results showed that Lanolin (Base E) gave the best result, and Liquid Petrolatum (Base B) the poorest. The others showed about the same degree of protection.

Direct comparisons were also made between zinc stearate, zinc oleate and zinc linoleate. Series were made consisting of three ointments made up with the same base, but each with a different soap. The result showed that the oleate and linoleate ointments are much better than the stearate.

The thing that showed out the strongest and might be of some pharmaceutical importance is that any ointment made up of vaseline or liquid petrolatum gives a higher percentage burns than the blanks.

Since the preliminary work indicated that lanolin followed by such oils as linseed, olive and cocoanut were best, ointments were prepared using these as the main constituents with slight modifications and additions of different chemicals.

The following ointments were prepared and tested:

No. 16	Zinc Oxide	25	On % of blank	No. 44	Magnesium Oxide	44	
	Linseed oil	25			Linseed Oil	43	
	Lanolin	50	37		Paraffin	1	
No. 31	Calcium Oxide	55			Base D	12	35
	Linseed Oil	22		No. 41	Manganese Rosinate	75	
	Lanolin	23	35		Base D	25	33

From the work done it was noted that the ointment prepared from an oxide with an oil appeared to give better results than the metallic soaps as ordinarily prepared.

The question of which oxide was best was then taken up, and over one hundred ointments of different proportions of CaO, ZnO, Bi_2O_3, MgO, oil and some base, generally lanolin or neutral wool fat, were used.

The results showed that calcium and zinc oxides gave the best results so a number of ointments of these two oxides were made and prepared.

The best ointments of these two classes were as follows:

No. 82	Calcium Oxide	40%	No. 66	Zinc Oxide	40%
	Linseed Oil	28		Linseed Oil	20
	Water	9		Lard	20
	Lanolin	21		Lanolin	20
	Wax	1			

The CaO ointment gave good results, while the amount of CaO in them appeared to be high, the effect on the skin was not harmful, this ointment being applied to the skin and tender parts of the body for two weeks without any injurious effect at all. But these ointments harden or "set" on exposure to air and on long standing, so that they would not be practical for field use.

The ZnO ointments gave the best results, and a series of ointments were prepared and tested; the four ingredients varied in different amounts in order to see if No. 66 could be improved either in its protective properties or in its physical properties.

The results obtained showed, when any very great change in formula is made, that every substance used has a definite function, and the percentage composition is the best.

The following ointment, No. 146, was recommended for field use:

No. 146	Zinc Oxide	45%
	Linseed Oil	30
	Lard	10
	Neutral Wool Fat	15

The physical properties of No. 146 are very good. It forms a smooth, even coating on the skin; sticks well enough not to rub off too easily on the clothing, and yet is not so sticky as to plaster down the hairs and be disagreeable. Its consistency is just about right to press readily from an ointment tube and to rub on the skin well. The change with temperature variation is not great. A tube was heated to 42° C for 12 hours without hardening of the ointment or separation of the oil. Another tube was kept in a freezing mixture at —10° C for several hours, and when removed the ointment could easily be pressed out and rubbed on the skin. Test tubes were filled to the top with ointment and left standing exposed to the air in order to see if the ointment tended to separate. After two weeks' time there was no sign of separation. A jar of No. 66 has been kept for a month and a half open to the air more or less every day, without apparent effect on the ointment, and the ointment has been used from day to day without noticeable change in consistency. The ointment contains nothing which could in any way injure the skin during constant use. The materials to make it are all plentiful and cheap except lanolin, but by using neutral wool fat this objection was overcome.

Neither the use of all lanolin nor of all lard gave as good results as part lanolin and part lard. This ointment has the best proportions and any attempt to improve or cheapen the product frequently impairs to a considerable extent the degree of protection against mustard gas. It has been found by experiments that slight and apparently negligible changes in the composition often seriously impaired the efficiency of the product. This fact cannot be too strongly emphasized, and exact adherence to the given directions were required.

The ointment was painty white, and for field use it had to be camouflaged, so we found that one percent burnt umber gave a very satisfactory color—a light brown tint—the one desired.

Many other materials were tried in ointments besides different stearates, oleates and linoleates. They were metallic resinates (these gave very good immediate results, but as a rule formed a very sticky mass on the skin which plastered down the hairs), aluminum chloride, ferric acetate, sodium carbonate, and sodium perborate, but without significant results. Among organic compounds chlorinating agents such as dichloramine and phenyliodide dichloride were used and also basic compounds such as oxamide, phthalamide and pyridine, all common oils, and a number of chlorinated oils. In no case were as good results consistently secured as when the regular ZnO ointment No. 146 was used.

At one time it was considered as a possibility that certain animal and vegetable oils alone rubbed on the skin might give as good protection as when made up in ointments with oxides and soaps. A number of oils were therefore tried, but none were found to give particularly good results as compared with the best ointments.

After these tests were made word was received from the A. E. F. laboratory that boiled linseed oil gave very good protection against mustard gas. Therefore another series of tests was made comparing boiled linseed oil with Ointment No. 66. The results showed the ointment gave the better protection. There were a number of drawbacks to using oil instead of an ointment. Repeated applications of boiled linseed oil gave a very unpleasant coating on the skin which slowly peeled off, causing a very marked degree of discomfort. None of the ointments made a coating even on repeated application for two weeks or more, making one or two applications a day.

The value of ointments for field use was subjected to some controversy, but Col. Bacon very emphatically stated that both American and Allied forces needed even partial protection such as was afforded by protective ointments. He stated that by far the greatest proportion of the casualties were caused by vapor burns and that the prevention of any reasonable percentage of these casualties would justify the use of a protective ointment.

It was found that this ointment gave more protection against high or medium concentrations than against long-continued exposure to uniformly low concentrations. But it was found that a large proportion of the men were exposed to high or medium concentrations and the use of the ointment would certainly prevent a considerable proportion of the casualties.

The directions were—rub on the ointment twice a day when exposure to mustard gas is anticipated. Do not apply to the whole body, but only to the crotch, in the arm pits, on the hands and feet, and exposed portions of the face.

This ointment gives good but not complete protection against mustard gas. It is a preventative only, and is of no value if applied after exposure to the gas.

The ointment proved its value a number of times. Men obliged to handle mustard gas who have made use of a protective coating of No. 146 ointment on their hands have been remarkably free from even slight mustard gas burns.

The manufacture and shell-filling plants have used this ointment with very satisfactory results. Men have worked over or taken apart machinery and apparatus containing liquid mustard gas with practically complete immunity from burns when they previously covered their hands and arms with ointment, put on protective gloves and subsequently washed off the ointment.

The ointments have also been used with distinct success in the impregnation of socks, underclothing and leather puttes and gloves, for mustard gas protection.

And this same ointment has also been found to give good protection against other powerful skin irritants which were going to be used when the Armistice was signed, and protective ointments were no longer needed.

SOME FUNDAMENTAL CONSIDERATIONS IN DISPENSING PHOTOGRAPHIC FORMULAS.*

BY IRWIN A. BECKER.

(A communication from the Chairman of the Sub-Committee on Photographic Formulas, A. Ph. A. Recipe Book.)

To the English reading and speaking photographic world the most potent single influence is the *British Journal of Photography*, together with its supplementary publication, "The British Journal Photographic Almanac, etc."

Naturally then, all weights and measures in these publications, when not expressed in terms of the metric system, are in terms of avoirdupois weights and "Imperial" fluid measure.

The very fact that a formula calls for a twenty or forty fluidounce quantity is a strong hint that the idea of the Imperial pint or quart suggested this amount, rather than some other influence. Also, photographic journals in this country (U. S.) largely quote from these publications, even to the extent of reprinting verbatim entire articles.

What mischief may be spread broadcast by this practice is nicely shown by an instance that happened during 1918.

The *British Journal of Photography* printed an elaborate exposition of the methods of reckoning percentage,—all, and properly so, based on avoirdupois weights and Imperial measure. These were generously copied or reprinted verbatim by various photographic publications in this country.

None, however, called attention to the essential difference in weight of the "Imperial" fluidounce of 437.5 grains and the U. S. liquid ounce of 454.6 grains, at ordinary conditions of temperature, pressure and humidity.

Therefore where a definite effect, or rate, or time limit is stated with any given formula of British origin, identical results can only be expected by actually duplicating the original formula. This can easily be accomplished in the absence of British measures, by weighing the fluids with avoirdupois weights, making due allowance, of course, for specific gravity where necessary. A general admonition is to pay close attention to cautions and precautions by manufacturers of, or dealers in, photographic materials.

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* Read before Section on Practical Pharmacy and Dispensing, A. Ph. A., New York meeting, 1919.